ROCHESTER INSTITUTE OF TECHNOLOGY
Kate Gleason College of Engineering
Department of Mechanical Engineering

Course: 0304-440 Numerical Methods (Computer Lab 4, Credit 4) **Required**

Course Description (10-11 Bulletin): This course entails the study of numerical methods as utilized to model and solve engineering problems on a computing device. Students learn to implement, analyze and interpret numerical solutions to a variety of mathematical problems commonly encountered in engineering applications. Topics include roots of algebraic and transcendental equations, linear systems, curve fitting, numerical differentiation and integration, and ordinary differential equations. Applications are taken from student's background in engineering, science and mathematics courses. The Matlab programming language is taught and utilized for computer implementation. (prerequisites: 0304-342, 347, 1016-318) Computer Lab 4, Credit 4.

Prerequisite(s): 0304-342, 0304-347 and 1016-318**.** ME students are expected to have completed Problem Solving with Computers, Engineering Mechanics, and Matricies & Boundary Value Problems prior to enrolling in this course.

Textbook(s) and/or Required Materials: Chapra, S.C. and Canale, R.P., *Numerical Methods for Engineers*, 6th edition, McGraw Hill, 2010. Additional on-line materials provided by the course instructor.

Course Outcomes / Relationship to Program Outcomes (1 = slightly, 2=moderately, 3=significantly):

Course Learning Outcomes	RIT Mechanical Engineering Program Outcomes								
	1	2	3	4	5	6	7	8	9
Level 1: Knowledge									
NM1.1 Learn numerical solution techniques for engineering problems	2		2	3					1
NM1.2 Learn MATLAB use and programming for engineering problem solution	2		2	3		1			1
Level 2: Comprehension									
NM2.1 Understand iterative numerical solutions via hand and computer calculations			2	3					
NM2.2 Understand errors in numerical computation	1		2	3					
NM2.3 Understand convergence of numerical solutions			2	3					
Level 3: Application									
NM3.1 Root extraction numerical methods.			2	3		1		2	
NM3.2 Numerical solution of linear systems of equations.			2	3				2	
NM3.3 Least-squares function fits to experimental data and interpolation of exact data.			2	3		2		2	
NM3.4 Numerical integration and differentiation.			2	3		1		2	
NM3.5 Solution of initial value, ordinary differential equations.			2	3		2		2	
Level 4: Analysis									
Level 5: Synthesis									
NM5.1 Use knowledge of engineering basics to formulate problems, choose the appropriate technique to solve and decide how to structure a numerical solution through manual calculation, computer calculation, or computer programming	2		3	3		1			1
Level 6: Evaluation									

Topics Covered:

- Introduction to Matlab computing and programming.
- Numerical Accuracy and Error Analysis.
- Root finding via bracketing methods: graphical approach, bisection & false position methods.
- Root finding via iterative methods: fixed point iteration, Newton's, & secant methods.
- Solving sets of linear equations via direct methods: Gauss elimination, Gauss-Jordan & LU decomposition.
- Solving sets of linear equations via iterative methods: Jacabi's, Gauss-Seidel & Gauss-Seidel with over-relaxation.
- Curve fitting and interpolation (start).
- Curve fitting and interpolation (finish). Numerical integration via trapezoidal and Simpson's rules.
- Numerical integration via Romberg integration, numerical differentiation.
- ODE's: Initial value problem solution via Euler's, Huen's and Runge-Kutta Methods

A student who successfully fulfills the course requirements *(0304-518)* will have demonstrated the ability to:

1. Conduct structured programming using a high-level language (MATLAB)
2. Identify the roots of equations using bisection, false position, fixed point iteration, Newton-Raphson and secant methods
3. Perform solutions of linear systems of equations using direct methods (Gauss elimination, Gauss-Jordan, LU decomposition) and iterative methods (Jacobi, Gauss-Seidel, Gauss-Seidel with Over-Relaxation).
4. Implement curve fitting techniques including least squares linear and non-linear regression, assessment of goodness of fit and interpolation/extrapolation using Newton interpolating polynomials.
5. Perform numerical differentiation and integration through implementation of the trapezoidal rule, Simpson's rule, and Romberg integration.
6. Conduct numerical solutions of initial-value ordinary differential equations, using Euler, Huen's, and Runge-Kutta methods

Class/Lab Schedule: The class meets for four (4) one-hour lecture/computer laboratory sessions each week.

Contribution of Course to Meeting Professional Component:

College Level Mathematics and Basic Sciences	= 0 credits
Engineering Topics	= 4 credits (4 engineering science)
General Education	= 0 credits

Prepared By: Mark H. Kempski **Date:** April 21, 2010 **Revised**: Same